Architecture for Flexible Command and Control Information Systems (INFIS)

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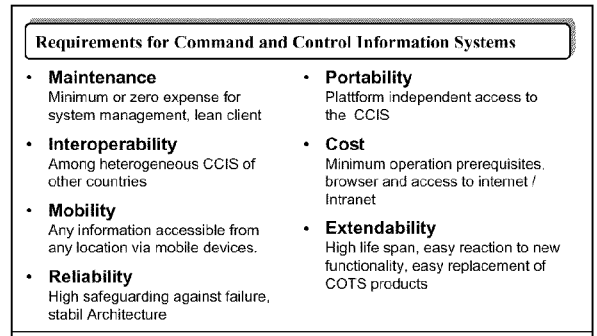
1 Processes of Change

Next generation CCIS will be leaner and more flexible. The previous trend to decentralise the computer power increased the complexity of local devices. Now it is more and more difficult to achieve the requirements of higher mobility and simpler access to information services.

The available bandwidths will raise. Communication via radio transmission will be extended. Robuster and more mobile devices use radio interfaces and will be established as standard. Due to the quick deployment of the internet a new network oriented client/server technology arises. The requirements for front-end devices change. Information services were transferred to decentralized server machines. All required services can be accessed from different local points by authorized users. Miscellaneous inhomogeneous technical characteristics of various information pools, that are time consuming and very annoying for users will no longer be relevant. The necessary expense for the administration of local devices will decrease and will be similar to the currant situation of mobile telephone devices – almost zero.

The change of the political conditions for military engagements causes the reduced importance of geographical distances. Decision cycles will decrease. In all sorts of military orders specialists are flexibly gathered for short time engagements. The importance of mobility will increase.
More and more often, specialists are gathered together at short notice for fast progressing operations. These persons should be supplied with easy to use but robust IT systems which require a minimum of expenditure for installation and configuration and support an operation of a partially mobile group distributed spatially.

The information processing will face the following requirements: Information have to be available in a short-term. Nearly any information must be accessible to the military leader. All different kinds of information, whether structured/unstructured or formatted/ unformatted or data-based that are necessary for the complete analysis of any particular situation, must be individually linkable.



Picture 1

That requires an extension of common CCIS data. The data for the description of e.g. "Situation of Own Troops" must be completed by links to corresponding e-mails, faxes, videos, graphics etc. These links must be variable and managed automatically. From the user's point of view, a homogeneous application system provides a complete and consistent information about all relevant facts.

The information exchange between military units must be manageable and should run automatically for horizontal and vertical information flows. Depending on the purpose, the used front-end devices must be scalable from laptops to e.g. mobile telephones. The IT-administration ought to be unnecessary. Mobile devices must be robust, simple to use, easily exchangeable and rapidly employable.

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2 Chances with Internet-Technology

The internet technology enables new scenarios for communication and cooperation of user teams that interact across long distances. It offers attractive means to access a CCIS. Nearly any kind of electronic storable information is accessible through an intranet or the internet. Variant types of communication are no longer limited to particular media. The internet handles voice communication, video telephoning, emailing, file exchange etc. The browser (COTS) is a universal tool within the web and easy to use. It enables the similarity of user interfaces. So the expense for teaching and operating of heterogeneous applications can be reduced.

Due to the working standardisation, the open interfaces, the open protocols and the open data formats within the arising systems and communication platforms are widely unique. Products of various suppliers are widely combinable and exchangeable. The communication between systems of different suppliers works quite well. This kind of a working and complete standardisation occurs not very often in the history of information processing.

Another relevant development, which is closely linked to the internet, is the standardisation of Java by the "Open Group", where all important suppliers and large user companies of information and communication technologies participate. The reason for Java's success is especially the platform independence of Java applications. Appropriate environments ("virtual machines") are available for almost every platform. All these virtual machines can operate the same Java-Byte-Code, that was compiled once from a single source code.

The internet technology offers considerable improvement potentials for all kind of business processes. But as in the case of all new technologies, we have to apply the means very carefully, because the enthusiasm of the technicians and customers which easily fall in love with the new things should not lead into the fatal situation, that the technique is in the foreground of considerations, but not the operational process that has to be supported by applying a technology.

3 Interoperability

The interoperability of heterogeneous applications can be eased by using internet technologies. For the lowest level of interoperability different applications can run in windows of a single browser. A further integration can be achieved when data of different data bases are collected and processed within a XML page. A sort of an intensive integration of heterogeneous applications is possible by using distributed agents. The properties of agents can be: intelligent, learning, interacting and if necessary mobile. In order of a user they can independently handle complex tasks.

But no one should expect miracles. Even if the integration of information from different heterogeneous sources is technically possible, one problem has to be solved always: the identical interpretation of information by the sender and by the receiver. In this context it seems to be more than doubtful, that it is possible some day to have a "machine" automatically interpret and automatically translate more than trivial facts.

In opposite to this consideration the consequently operated standardisation of logical semantics is a certain way to achieve interoperable systems. In that case ATCCIS[1] (Army Tactical Command and Control Information System, NATO-project) has established developing specifications for a unique replication protocol to share data automatically between different command control systems based on an agreed conceptual data model.

4 Future Front-End-Devices

Few years ago the NC (Network Computer) was supposed to reduce the necessary management efforts. These efforts came up due to the increasing decentralization and number of installed PCs. Frequent troubles among the PC environment caused by instable operation systems and poor network software required intensive personal efforts for system management tasks. An increasing complexity of applications needed higher performing devices though just a small amount of functions was actually used.

There are several reasons for the actual silence around the NC. On one hand the current operation systems are more stabile and better management tools support the remote maintenance of local devices.
On the other hand all requested facilities have already become reality due to the increased utilization of internet technologies. It is possible to choose between local, server based or web based

work. This is important for the data administration and the access to the application. There is an actual movement in the direction of web based work.

5 Transmission

Future networks must transmit nearly all sorts of information: voice, data, video etc. Today we can observe a competition between ATM and IP-based networks. Also a combination of IP via ATM might have its way. But probably the importance of pure telephone networks will decrease. Future investments will extend the capacities for combined voice and data transmission.
Fiber technologies can enable bandwidths of more than 100 Gbit/s in the future. In tests transmission capacities of several tera-bits/s could already be achieved for distances of several kilometres. Due to actual plans an enormous increase of capacities seems to be expectable.

Particularly the radio transmission is going to obtain an increasing importance. It provides advantages for handling and flexibility. The GSM (Global System for Mobile Communication) technology, which is used for mobile telephones offers a bandwidth of 9,6 kbit/s. That is sufficient for voice communication but not enough for further requirements. The package oriented GPRS technology (General Packet Radio System) supplies up to 115 kbit/s. An advantage for data transmission is expected because the transmitted volume can be charged instead of the time for a connection.

Today different technical equipments have to be used, depending on the available radio cells. In example DECT is used in small cells like an apartment. Bundle transmission is used on a production site, GSM over land and INMAR-Sat over sea.
Starting in 2002 UMTS (Universal Mobile Telecommunications System) is supposed to supply one technique for all kinds of radio cells. Bandwidths up to 2 Mbit/s are planned for devices. This commerce driven technology is an incentive for an increasing usage of mobile devices.

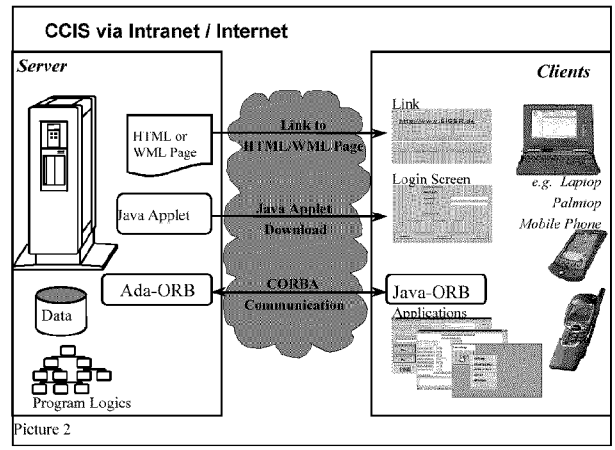
6 Architecture Proposal

The proposed architecture is an "Integration Platform for Flexible CCIS". It is called **INFIS**[3] (in German: **IN**tegrationsplattform für **F**lexible FührungsInformationsSysteme).

The INFIS architecture is based on COTS products (hardware, database, operational system, network, middleware, browser, programming-language and referring tools) and standard concepts for the database (ATCCIS).

INFIS includes a CCIS as the essential component. It essentially contains the features: situation management, replication mechanism, flexible contract management for the replication mechanism, message handling, mobile agent controlling for the distribution of client software, database handling.

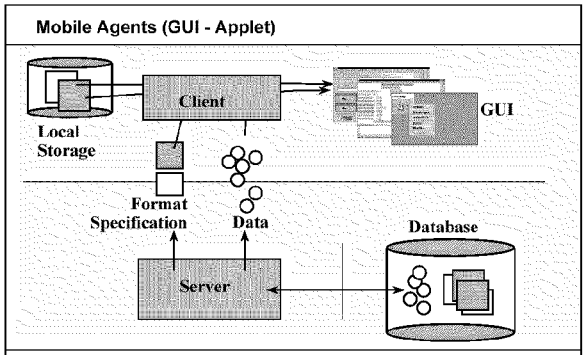
The internet technology enables the platform independent[2] access of any stationary or dislocated devices to any INFIS service like the database applications of the leading CCIS or any other application e.g. for message management, graphical situation display and in the future for integrated office applications, document management and so on.



Picture 2

The first action to access INFIS on all sorts of devices is the download of an applet from the server (pict. 2) via internet / intranet. From that time on the communication runs via the middleware CORBA (Common Object Request Broker Architecture).
The use of CORBA within the structure of a flexible system provides a relative independence of server and client. The encapsulation on side of the server enables the usage of any hardware, any operation system, any database operating system and any programming language. Even legacy applications, that still meet the actual requirements, might be operated and used via modern graphical user interfaces on side of the client.

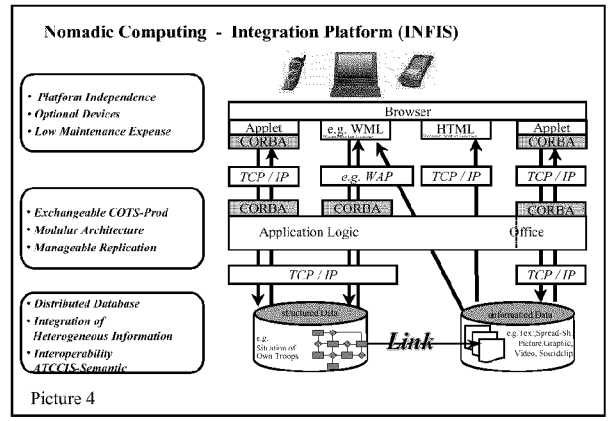
A browser enables the access to the application logic, which itself controls the access to the structured database. The applet, downloaded first, consists of the client functions like reasonable checks, format handling, data handling. It also handles the communication to the server. Now the format specifications and data can be sent from server to the client. If a local storage is practical, the format specifications, which have been downloaded in former sessions, are used (pict.3).



Picture 3

Due to that architecture, the perpetual transported data volume between server and client is small. However, this advantage faces a uniquely longer charging time during the first download of the applet onto the client.
If in case of any software maintenance the database or the application is extended or changed, there is nothing to do on side of the client. This advantage supports the mobility and independence of the users.

As mobile devices conventional laptops, palmtops or mobile telephones can be used. The choice of the device depends on the required functionality. In all cases the single prerequisite on the device is a common browser – any installation of further software on the device can be omitted .
Conventional laptops use conventional browsers like Netscape or Explorer (pict. 4). At present the WAP technology (Wireless Application Protocol) is applicable for small devices to transfer graphics or texts. WAP is comparable to the common internet technology. WAP uses WML pages (Wireless Markup Language). The structure and usability of WML is similar to HTML (Hyper Text Markup Language) pages.
Nowadays the used path (Applet or WML) depends on the selected device. The retrieval and the data input into the structured data base is possible in both cases.



Picture 4

For the near future the mobile telephone producers have announced a Java Virtual Machine running on their devices. If that environment is available on mobile telephones, the WAP technology can be replaced by the well known internet technology. That means, that the same program techniques can be used for every device. Programmers must only consider the size of the display.

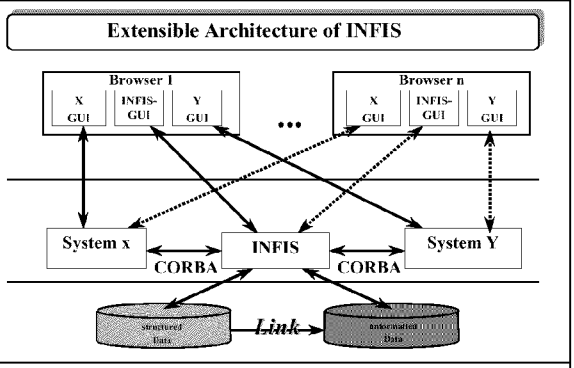
To create or manipulate unformatted data (text, pictures, graphics, videos, sound clips, ...), an appropriate application e.g. an office software is required. At present an extra installation of a proprietary office software (e.g. MS-WORD) on the local device is required. Several suppliers intend to ship office products that can be used via internet in the future. These products require only a browser on the local device. In that case it is possible to retrieve documents via a browser and also to manipulate documents via the browser without (or at least with minimum) requirements for local software installation.

The INFIS architecture enables the extensibility through other applications for particular purposes (pict. 5): office products, e-mailing, document management and so on.
The CORBA connection encapsulates the additional systems. The communication between INFIS and each of these COTS systems is implemented in pairs of CORBA interfaces[2].
The prerequisites for the extension are:

1. the additional COTS systems have a 3 tier architecture,
2. they are able to run in a browser and
3. they have an common programming interface or better a CORBA interface.

If one of these COTS products should be replaced in future by a more powerful one, the pair of

CORBA interfaces on at least one side must be adapted.
Faced with the fast evolution of internet technology and the circulation of Java applications, it seams to be likely, that in future many COTS products meet these requirements.



Picture 5

It is planned to advance the INFIS architecture for the following purpose: The user should be allowed to manage individual links to any information. These information must be flexibly linkable depending on the particular operational situation. In this case, the leading system within the INFIS-architecture, the CCIS must manage the links in connection to referring situations in the database. I.e. it might be helpful for the military leader to link the daily internet weather report to the corresponding operational situation or to link a video clip from an area of interest with the operational planning.

Features of the INFIS - Concept

- **Cost effective**: any (even mobile) Devices, Browser, access via Internet / Intranet
- **Minimal/none Expenditure for Administration** due to Lean Clients, (in the future: Mobile Phones too)
- Integration of **heterogeneous Information** (structured, unformatted)
- **International Interoperability** to heterogeneous Systems (ATCCIS-Standard: Replication Mechanism, Conceptual Core Data Model).
- Dynamic Architecture and easy Replacement of COTS-Products: **high Life Span**, flexible Maintenance, fast Reaction to new Operational Requirements
- **Portability** due to Hardware- and Operation-System Independence

Picture 6

The regard of international standards – especially in the area of semantic standardisation of objects occurring on the battlefield and their relation with each other – promotes the interoperability to other systems. INFIS implements the concepts for the ATCCIS data base and the replication mechanism.

A consequent modular design enables a flexible architecture and the easy integration and the replacement of single (COTS-) components. That allows the easy maintenance and fast reaction to new requirements coming up in the future. That again is the preposition for a long term actuality and utility of a CCIS.

Due to the typical causalities of procurement and life cycles of military information systems this feature is considerably more important than in the case of civilian systems.

Via a military intranet, the access to sensible information can be controlled and the management of the information pool can be well coordinated.
If an e-mail system is part of the mentioned architecture, the information distribution (push-principle) to determined receivers and the active receipt (pull-principle) of requested information from a distinct source is possible. Command and control processes may become leaner, quicker and over all more efficient.

7 Future Developments

Computers get smaller and more powerful. Hard drive capacities increase while their size gets smaller. Nearly every equipment gets a better performance and more memory. In opposite to these enhancements the man machine interfaces of computers are still very poor. Computers are forcing users to accept its rules, which often are rather complex. The man machine interfaces of other very complex technical devices which surround us all day, are better adapted to the ergonomic needs of human beings. E.g. a lot of electronic gadgets control the driving unit in a modern car. The actual load of the motor, the fuel quality, the compound of the exhausted gas, the acceleration and so on. All these values must be computed, but they remain concealed for the driver. He "programs" his car just with the movement of his right foot. That is in fact an ergonomic interface.

In accordance with the mobility of computers additional requirements arise. It is still necessary, that palmtops or laptops have to be operated intentionally. Another activity must be interrupted to lead the full attention to the computers man machine interface.
Future computers can be used while other activities are carried out. An actual, primitive example is the

usage of mobile telephones while driving a car. The voice control is an improvement to the user interface. The driver uses the telephone services and keeps on driving just with little distraction.

This is just the beginning. Computers that are imperceptible and wearable like watches on the arm were controlled by the voice or collect input parameters automatically. The output might be handled via transparent visors or via a synthetic voice. These kinds of interfaces can support a new kind of interaction with computers.
Further considerations have to be made in order to develop architectures that support flexible military information systems, which allow an information management of dislocated users with mobile and easy manageable systems .

8 Literature

1 Army Tactical Command and Control Information System (permanent), SHAPE Policy & Requirements Division, Mons (Belgium)

2 Bühler, Fassbender (1999); Applying Ada, Java, and CORBA for Making a Command and Control Information System Platform Independent; SIGAda'99 10/99 Redondo Beach, CA, USA

3 Wunder (2000); Architektur für flexible Führungsinformationssysteme, IT-Report 2000, Report Verlag, Bonn-Frankfurt